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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

NORTHEASTERN FOREST EXPERIMENT STATION

AMHERST, MASSACHUSETTS

1928

1927-1928

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Amherst, Mass.

Annual Investigative Program

1928

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Northeastern Forest Research Council.

Maine

Appointments expire in 1930:

E. B. Draper	Timberland owner.

Appointments expire in 1929:

G. T. Carlisle, Jr.	Consulting forester.

New Hampshire

Appointments expire in 1931:

J. H. Foster	State forester.

Appointments expire in 1930:

J. C. Kendall	New Hampshire Agricultural Experiment Station.

Appointments expire in 1928:

W. R. Brown	New Hampshire Timberland Owners' Association.

Vermont

Appointments expire in 1929:

R. M. Ross	Commissioner of Forestry.

Massachusetts

Appointments expire in 1931:

R. T. Fisher	Harvard Forest.

Appointments expire in 1930:

Pres. R. W. Thatcher	Massachusetts Agricultural College.
Pres. E. H. Thomson	Federal Land Bank.

Connecticut

Appointments expire in 1928:

W. L. Slate	Connecticut Agricultural Experiment Station.
Prof. J. W. Toumey	Yale School of Forestry.

New York

Appointments expire in 1931:

G. W. Sisson, Jr.	Racquette River Paper Co.

General Policy

Scope and Character of Work

The last two or three years have seen a definite trend toward concentration of studies at working centers. The first permanent sample plots, consisting of a series of four methods-of-cutting plots, were established in 1924. These were followed in 1925 by two slash disposal plots and in 1926 by a set of three additional slash plots. In 1927 four weeding plots supplementing the four methods-of-cutting plots were established. All of these plots are located at Cherry Mountain in the White Mountain National Forest. Studies of tree form, as well as a study of factors controlling the establishment of reproduction, are also under way at Cherry Mountain. Measurements of total radiation by means of the thermopile and galvanometer were carried on for short periods during 1926 and 1927. Intensive studies of this character demand certain routine observations which must necessarily extend over a long period of time, and at the same time tend to concentrate work on local areas.

Another center at which considerable work is at present under way is the Harvard Forest at Petersham, Mass. Studies of light, soil moisture, and climatic factors in connection with methods-of-cutting, slash disposal, soil, and fire-weather studies, as well as entomological and pathological studies, have been concentrated at this point, where laboratory and equipment offer special facilities for this work. The nature of the fire-weather project has necessitated the concentration of field work at four fire-weather stations; Cranberry Lake, N. Y., Petersham, Mass., Elk Lake, N. Y., and Smyrna Mills, Me.

This concentration of project work is in striking contrast to the extensive travel throughout the region (in search of suitable material for the general studies undertaken) during the first two years of the Station's existence. Certain phases of these studies have been completed, forming the basis for manuscripts which have been submitted for publication. Such general studies, however, will continue to form an important part of the Station's work for a number of years to come.

Branch Stations.

The formal agreement covering the establishment of the White Mountain branch of the Northeastern Forest Experiment Station was approved last summer by the Acting Forester. At that time the Bartlett and Gale River areas were selected, and, all factors considered, they were undoubtedly the most suitable that could have been chosen. However, the possible acquisition by the Government of the lands in the Waterville valley presents a new angle to the question. The Bartlett area meets most of the requirements demanded of a branch station. The Gale River area, on the other hand, although fairly accessible and containing a good range of forest types, sites, soils, and topography, lacks the well-developed market of the Bartlett area. No timber is being cut at present on the Gale River area. A possibility exists of marketing a limited amount of cordwood in the town of Bethlehem, but this market and others have not yet been developed. In fact, it is doubtful if any appreciable demonstration cuttings can be made for many years to come. In the Waterville tract it is quite certain that cutting operations will be active indefinitely. The large-scale cutting operations by the Parker-Young people on this tract for the next 15 years will be followed by portable mill operations at various points in the valley, assuring a ready market for timber crops. The area presents excellent opportunities for reproduction, slash disposal, and growth studies in the various forest types, since cuttings of all ages may be found in the valley. It is readily accessible; when the proposed four-mile stretch of road leading to Passaconway is built, a through east and west road will cut midway through the tract. It presents an excellent opportunity for adopting the policy of setting aside virgin tracts as museum specimens; provision has already been made for leaving intact some 800 acres of virgin spruce, largely in the spruce slope type, should the Forest Service acquire the area. One of the few remaining virgin tracts left in the spruce and hardwoods type lies in the center of this area. It may not be advisable to abandon the Gale River area in favor of the Waterville tract as a demonstration area; but in case the Forest Service acquires the tract, as now seems likely, it should by all means be used as a branch station of the second class.

Although present plans call for the eventual establishment of branch stations in central Vermont, northwestern Maine, the Adirondack regions of New York, and the Allegheny hardwood region of southwestern New York, no active steps have been taken in this direction. Since national forest land in the Northeast is limited to New Hampshire and a very small portion of Maine, the proposed branch stations must be established through cooperation with state foresters, forest schools, lumbermen, and other interested agencies.

Personnel.

Mr. Dana, who had been director of the Northeastern Forest Experiment Station since its establishment in 1923, resigned in August, 1927, to accept the position of dean of the new Michigan School of Forestry and Conservation at Ann Arbor. Dr. John S. Boyce, chief of the Portland, Oregon, Office of Forest Pathology, Bureau of Plant Industry, was appointed to the directorship of the Station. The necessity of first completing the work of important research projects under way postponed the arrival of the new director until the middle of March, 1928. During the interval following Mr. Dana's resignation and the arrival of Dr. Boyce, M. Westveld of the Station staff was appointed Acting Director. On account of the impending resignation of C. E. Behre, R. G. Wheaton was appointed Assistant Silviculturist, and reported at the Station for duty September 1, 1927.

Cooperation.

Northeastern Forest Research Council.

The regular summer meeting of the Northeastern Forest Research Council was held June 23 and 24, 1927, at the Pack Demonstration Forest of the New York State College of Forestry at Cranberry Lake, New York. The first day was spent inspecting parts of the College Forest and visiting the fire-weather stations operated by the College in cooperation with the Northeastern Forest Experiment Station. The evening was spent in an informal discussion of general forestry problems and problems in forest research.

The Council held its business meeting the following morning. Mr. Dana called attention to the three vacancies existing in the Council membership, due to the resignations of H. G. Philbrook and E. M. Lewis and the expiration of the term of C. H. Keith.

The Chairman of the Council, Mr. Brown, stated that President Garfield of Williams College is considering the possibility of starting something in the way of forestry there. If this plan develops the college might be able to offer inducements to the Station to move its headquarters to Williamstown, including quarters and perhaps additional financial assistance and an experimental forest in close proximity to the town. A question was raised as to whether the Forest Service would care to consider moving the present headquarters of the Station, unless it should prove impossible for the Massachusetts Agricultural College to continue to provide satisfactory quarters; and also as to whether, if Williams College could make available an experimental forest, this might not be used as a sub-station similar to the proposed branch stations in other parts of the region. In the absence of any concrete proposal, the matter was discussed briefly without attempting to reach any decision as to the desirability of a change of headquarters. Among the matters discussed in detail was the McSweeney Bill, which received favorable comment.

It was planned to hold the winter meeting some time in February, but owing to the late arrival of Dr. Boyce at Amherst the meeting was postponed until May 1. It was held in the Chamber of Commerce, Kimball Hotel, Springfield, Mass., and was well attended. The question as to the need of undertaking a cordwood piling study to determine the solid contents of stacked cords of second growth spruce stands of different ages was discussed in considerable detail. The advisability of undertaking a study of the application of spruce normal yield tables to understocked stands was also discussed, as was the need for working up the data secured from the series of sample plots established by the Forest Service in the Northeast some 20 years ago. The Council agreed that the latter two studies were of more importance than the cordwood piling study, and that the Station should incidentally secure data on the cordwood piling study through the cooperative efforts of pulpwood companies and other agencies undertaking work of this character.

President Thatcher of the Massachusetts Agricultural College said that he considered the Station an asset to the College and should be sorry to see any effort made to move the Station elsewhere. He felt that in case of an enlargement of the Station additional space could be obtained, although it is not now available.

Professor Fairchild, director of the Forest Taxation Inquiry, gave a history of the organization of the Inquiry, emphasizing the point that the Inquiry was a fact-finding organization and would continue in that capacity for the next several years. He stated that it was not yet ready to make recommendations for forest legislation. The Inquiry is preparing to start work in the Northeast in the near future; it will make a long-range study of the historical and economic development of the region.

The vacancies referred to at the summer meeting were filled by the appointment of President R. W. Thatcher of the Massachusetts Agricultural College; W. G. Howard, Superintendent of State Forests, Conservation Department of New York; and E. B. Draper, Maine timberland owner and operator. R. T. Fisher, J. H. Foster, and G. W. Sisson were reappointed for a four-year period.

Although no definite time and place was designated for the summer meeting, Professor Toumey invited the Council to meet at the Keene Forest some time during the week of September 9-15.

Massachusetts Agricultural College

Cooperation with the Massachusetts Agricultural College has continued to be satisfactory. The Station now occupies the two large south rooms on the first and second floors of French Hall, in addition to two smaller rooms located on the third floor of Clark Hall which are occupied by Dr. Spaulding and his assistant. With from 15 to 18 people comprising the Station force during the winter months, the French

Hall quarters are badly crowded, and there is little chance of alleviating conditions in the near future through the acquisition of additional space from the College. The passage of the McSweeney Bill will result in a gradual increase in the force and a consequent need for enlarged quarters. President Thatcher, who is very much interested in the work of the Station, is confident that he will find a way to provide the necessary space to meet the growing needs of the Station.

A course in forest ecology was offered by the Division of Horticulture last year at the College summer school to advanced students. This course lasted for six weeks, and was handled by the Department of Forestry and the Northeastern Forest Experiment Station. Mr. Stickel of the Station staff handled the course for about two weeks, his work at Petersham being carried on by his assistant during his absence.

Other Cooperating Agencies

The establishment of an additional fire-weather station was made possible in 1927 through the financial assistance of the Maine Forest Service. This station, which is located at Smyrna Mills, Maine, makes a total of four now in operation. Two of these are located in New York: one, which is on the west side of the Adirondacks at Cranberry Lake on the Pack Demonstration Forest, has been maintained since 1925 by the New York State College of Forestry; the other, established in 1926 on the east side of the Adirondacks at Elk Lake, was maintained last year through the generosity of Finch, Pruyn and Company (who furnished quarters and subsistence to the observer) and the New York Conservation Department (who paid the observer's salary). The remaining station, established at Petersham, Massachusetts in 1926, has been financed since its establishment by the Harvard Forest. Of the $1100 furnished for the Petersham station last year, approximately $400 was expended for equipment.

Assurance has been received of continued cooperation in the fire-weather study this year at Petersham from the Harvard Forest to the extent of $1000. The New York State College of Forestry has agreed to finance the station at Cranberry Lake from June 1, 1928 to the end of the season. Finch, Pruyn and Company continues to provide subsistence and quarters for the observer at Elk Lake. The New York Conservation Department has contributed $150, available for expenditure prior to July, towards the maintenance of the station at Elk Lake. Unless further cooperation is secured from either the New York Conservation Department or the Empire State Forest Products Association, the maintenance of this station after July 1 will have to be financed with Station funds. The Maine Forest Service has agreed to finance the Smyrna Mills station for the coming season.

As an initial step in the scheme proposed by the Advisory Council of securing cooperation in other important projects requiring investigation which cannot be handled adequately by the Station, owing to lack of funds, the Vermont Forest Service furnished the services of one man, who assisted one of the Station staff in the remeasurement of a set of seven old permanent sample plots established by the Forest Service in 1906 at Shelburne, Vermont. Thirteen new permanent sample plots were established: ten on the Battell Forest near Middlebury, Vermont, and three on the Plainfield State Forest.

The fund which was contributed by interested timberland owners to make possible the study of the white pine weevil will be exhausted August 31, 1928. However, the Bureau of Entomology will be in a position to finance the work this year. Mr. MacAloney, who is in charge of this study, spent two months last year in Nova Scotia and New Brunswick coordinating the work done by the Dominion Entomological Branch with that done in the Northeastern states. Cooperation in this project is being continued with the Vermont State Department of Agriculture and the Connecticut Agricultural Experiment Station. Cooperation in insect studies being handled by Mr. Peirson, notably that on the spruce bud worm, is being continued with the Maine Forest Service. Mr. Peirson spent two months with the New York State Products Association making a survey of the bud worm situation in the Adirondacks. Two cooperating agencies are making studies of the bronze birch borer; one is the Maine Forest Service, the money being contributed by interested timberland owners and handled by the Forest Service as a cooperative fund; the second is the Bureau of Entomology, which has concentrated its work during the past season largely in New Hampshire and Vermont.

To further the maintenance of contacts with agencies and individuals in the region interested in forest research, the Station compiled a list of all the permanent sample plots thus far established in the Northeast. Mimeographed copies of this list will be given a wide circulation.

Mention should be made here of the continued satisfactory cooperation being maintained with the Bureau of Plant Industry, the Bureau of Entomology, and the Weather Bureau. The close contact which the Station staff has developed with these men is increasing in value.

A list follows of the cooperative funds received by the Northeastern Forest Experiment Station and expended during the fiscal year 1928:

	Deposited with Forest Service	Disbursed by Agencies
Harvard Forest	$1,000.00	
Maine Forest Service	536.32	
Finch, Pruyn and Co.		$540.00
Timberland owners		357.00
Vermont Forest Service		280.00
New York State College of Forestry		520.00
New York Conservation Department		500.00
Maine Forest Service		965.00
New Hampshire Forestry Department	354.25	
	$1,890.57	$3,162.00

Major Projects Progress and Plans

Methods of Cutting and Natural Reproduction (Mc 1, M. Westveld).

These studies have been confined heretofore to the principal types occurring in the spruce region. There are two phases to this project - that dealing with the study of conditions on cut-over pulpwood lands and that dealing with the establishment of permanent sample plots to supplement the results secured in the first phase of the study. In connection with the study of cut-over lands, some 420 temporary sample plots have been established in the spruce regions of Maine, New Hampshire, Vermont, and New York, attention being directed to reproduction conditions and the increment produced since the areas were logged. In addition to the four permanent methods-of-cutting plots established in the White Mountain National Forest in 1924, two half-acre plots were established during the past summer in the Battell Forest, Vermont - one plot to be clear cut of all timber; the other, on which unmerchantable and wolf trees will be left, to determine the effect of the two different treatments on the development of subsequent reproduction and reproduction already established. The material secured in the general study of cut-over spruce lands and the data yielded by the permanent methods-of-cutting plots since their establishment form the basis for a comprehensive report entitled "Reproduction on Cut-over Pulpwood Lands in the Northeast and Suggestions for Their Management", to be published in the near future as a Department Bulletin.

Continued progress is being made on the study of factors affecting regeneration in the various spruce types occurring in the region. During the past year 48 seedbed condition plots sowed to spruce and fir seed were added to the series of 36 established two years ago. So far, highest survival of both spruce and fir seedlings has been recorded on seedbeds comprising old, decayed, windthrown trees and logs; while lowest survival was noted on seedbeds consisting of a thick mat of spruce and fir needle litter accumulated to a depth of four to five inches. Two rechartings of the special reproduction quadrats located on the methods-of-cutting plots have been made since their establishment in 1924. The luxuriant growth of fern and oxalis which occurred on moist situations prior to cutting has given way to dense masses of raspberry growth, while on the better drained sites witch hobble and clumps of mountain maple are taking possession. The effect of various changes in plant associations on the establishment of new reproduction and development of advance reproduction following the opening of the stand is being studied in detail on these quadrats. Observations so far indicate that very little spruce and fir reproduction succeeds in establishing itself in the dense growth of raspberry bushes and shrubby growth that take possession of areas following cutting. Continuous records of radiation were obtained in the various methods-of-cutting plots where varying degrees of crown density are represented. These records were continued for a period of two weeks during the month of June, and compared with records secured for an equal length of time during the previous September.

From the study of cut-over pulpwood lands, particularly those in the spruce and hardwoods type, it is evident that in order to maintain the desired proportion of spruce and fir, cutting must later be followed by "cleanings". In order to secure data on the cost of "cleanings" and at what time in the life of the stand they should be made, a number of cleaning plots were established last summer. Two sets of four plots each were established in four-year-old cuttings in the spruce and hardwoods type - one set on the Battell Forest in Vermont, the other on the Cherry Mountain sale in the White Mountains. In each series one plot was held as a check plot, while the remaining three were subjected to cleanings of varying degrees of intensity to determine their effectiveness in increasing the representation of spruce and fir in the next rotation.

A number of old Forest Service methods-of-cutting plots, which were established some 20 years ago in the spruce region of New Hampshire and Vermont, were remeasured during the past summer. The increment data obtained from these plots will be a valuable addition to those obtained from the 420 temporary plots previously referred to as having been established in various aged cuttings throughout the spruce region. The figures are now being compiled and form the basis for the study of growth and probable yields on cut-over lands in the various spruce types. Plans for the coming year call for the establishment of additional methods-of-cutting plots - one series on the proposed sale in Cherry Brook Valley and the second in the Waterville Valley, provided this tract is acquired by the Forest Service. Considerable routine work will also be done, such as the remeasurement of the intensive quadrats on the Cherry Mountain plots and the tallying of seedlings in the seedbed condition experiments at intervals. Mr. Morgan of the Connecticut Agricultural Experiment Station will spend some time with Westveld this summer in order to continue studies on the Cherry Mountain plots of the relationship between soil conditions and the establishment, development, and composition of reproduction.

Studies of growth and reproduction conditions have been confined almost entirely to cut-over areas on which no fires have occurred since cutting. Burned-over areas from a few to several thousand acres in extent occur in the various spruce types throughout the spruce region of the Northeast. Our present knowledge is meager concerning what happens on burned-over spruce lands with respect to the development of a new crop of timber, the conditions under which they regenerate, and the factors governing these conditions. It is planned to extend the reproduction study this year to burned-over areas both in cut and uncut stands.

The trip planned to Newfoundland for the purpose of studying the results obtained on a set of twelve methods-of-cutting plots established seven or eight years ago did not materialize, and an effort will be made to make the trip this year.

Slash Disposal (Mb-1: Spaulding, Westveld, and MacAloney).

Investigations of the rotting of slash of hardwood species have been continued in northern New England and New York. General observations on rotting slash in this region show that there are two conditions which hinder rapid decay. These are quick and excessive seasoning and waterlogging. Certain factors, which are active everywhere, control these adverse conditions, irrespective of any methods of slash disposal (except burning) that may be used. A tentative alignment of the factors concerned has been made, and it is believed that this will finally lead to a real solution of the entire problem. Indications of the trend of results have been determined in this way. Because of the lack of comparable material under the same conditions, it has not been possible definitely to determine the effect of lopping. Apparently this will have to await the results to be obtained from the permanent slash plots which have been established at Cherry Mountain. In the meantime only tentative conclusions can be stated. The chief factors governing the rotting of slash are: the moisture of the soil and air, the direction and steepness of slope upon which the slash is left, the species of tree furnishing the slash, the rate of growth of the tree furnishing the slash, the season in which the cutting is done, the kind of soil on which the slash rests, the elevation of the place, and the canopy or cover, or both.

The moisture of the soil and air is of the greatest importance in controlling the decay of slash. Decay cannot progress in wood containing a minimum of water, nor can it in waterlogged wood. Waterlogging is a most important condition, and is prevalent in the northern forest region. Anything tending to promote it is a hindrance to the decay of slash. In general, a soil with moisture favorable for good corn or potato growth is also favorable for rapid decay of slash. The species have been tentatively ranked in their readiness to become waterlogged as follows, beginning with those waterlogging most readily: yellow birch, beech, oak, basswood, aspen, maple, poplar, paper birch, chestnut, ash.

In northern New England and New York the steepness and direction of a slope appears to be more important than has been generally recognized. In general, slopes facing to the south and west are warm and relatively dry; those facing to the north and east are cold and apt to be moist. The local topography has much to do with the condition on the slopes of the northern mountains, and greatly influences the speed of decay of slash lying there. The differences are so pronounced that the best recommendation for one may turn out to be the worst for the other. On the warm slopes slash may dry out promptly and thus resist decay, while on the cold ones it may become waterlogged and resist decay equally long, both being conditions leading to slow decay of the slash. Since much of the northern forest is on slopes of some sort, this question is a vital one and cannot be settled arbitrarily.

Hardwoods in the Northeast vary greatly in the durability of their wood. The wood of one may rot, but not disintegrate, in three or four years, while that of another may persist for nearly as many decades. The species have been tentatively ranked according to the durability of their slash as follows, beginning with the least durable ones: aspen, poplar, paper birch, basswood, beech, maple, yellow birch, ash, oak, chestnut.

The rate of growth of the tree from which the slash comes appears to be quite important. With a few exceptions sapwood rots more quickly than heartwood of the same species. In general, rapidly grown trees have more sapwood than those of slow growth. There is little or no difference between the sapwood and heartwood of aspen, poplar, and basswood in the rate of decay. Species showing moderate differences in the rotting of sapwood and heartwood are: paper birch, beech, maple, and yellow birch. Those showing decided differences are: ash, oak, and chestnut.

Since practically all cutting in this region is done during the dormant season, the effect of cutting in different seasons need not be considered.

Concerning the soil, practically nothing is known of its influence upon decay of slash, except in connection with its water and heat relations.

The elevation of the cut-over area has some influence on the rate of decay, since the length of the season when fungi can grow may be controlled directly by it. A variation of but a few hundred feet sometimes makes considerable difference.

Shade made by the canopy or cover, or both, greatly influences the moisture of the soil beneath. Complete lack of such shade is apt to produce excessive drying of the soil and abnormal heating by the sun. Where a selection cutting results in reducing the crown cover about a half, decay is apt to be favored.

A thorough consideration and weighing of all these factors as encountered in combination cannot be done hastily. Much checking under varying conditions must be done before recommendations can be made confidently. However, the following conclusions have been tentatively reached:

The method of disposal of the slash has much to do with its rate of decay. The usual way of cutting in the Northeast is selection cutting for a single species, or clear-cutting for all species. The former results in scattered slash which is commonly left as it falls. The latter results in the formation of rough windrows of slash between which the hauling trails and roads run. The effect of lopping of the tops has come quite insistently in question. Lopping theoretically leaves the slash lying close to the soil where decay will be favored by the moisture. In northern New England the average rainfall is great enough so that it is doubtful whether it is necessary for the slash to lie directly upon the soil for decay to be favored by the moisture. Too little data have yet been taken to yield conclusive results, but the rather contradictory evidence obtained hints at decided variations in the action of lopping in different situations. However, in any case the effect of lopping varies with the species somewhat as does the durability of the wood of that species. Naturally, the less durable species show the smallest differences between lopped and unlopped slash, simply because the wood rots quickly in any case, and the cost of lopping is not justified by a few months gain in the speed of rotting. Ranking of the species, beginning with those showing the smallest differences between lopped and unlopped slash has been tentatively done as follows: aspen, poplar, paper birch, basswood, maple, beech, yellow birch, ash, chestnut, oak. Lopping of the first four is not justified, because of the short period of decay needed by them. Lopping of maple and beech depends on the local conditions. These species do not waterlog very readily, and usually lopping may be expected to hasten decay somewhat. Yellow birch, because of its extreme readiness to waterlog, should hardly ever be lopped. Ash, chestnut, and oak, in most situations where they grow, will give maximum results from lopping.

The stationing of a man at Petersham during the summer to take data on weather conditions in relation to fire danger gave an opportunity to run recording instruments for humidity and temperature in the top and in the bottom of a pile of white pine slash. The data show plainly that in general the humidity is greater and the temperature lower beneath the slash, which was assumed, but with no definite data to prove that fact. It is hoped to continue the records for another year at least. If these records can be continued long enough to furnish reasonably close annual averages, it is hoped to determine finally the conditions which control the occurrence of certain wood-rotting fungi in the slash piles. Studies also on the influence of insects in promoting slash decay are being continued on the Harvard Forest by the Bureau of Entomology.

The three slash disposal plots, each 3.6 acres, established on the Cherry Mountain sale area in the fall of 1926 were logged during the winter of 1926 and 1927. On the first plot both hard and softwood slash was lopped; on the second no slash disposal was practiced; while on the third softwood slash was burned and hardwood tops left undisposed.

Reproduction tallies by milacres along reproduction strips were tallied prior to and following logging. The milacre plots also served as a basis for a vegetation tally, a record being made of the percentage of each milacre covered with vegetation; while for each tenth milacre a record was secured of the percentage of the area in possession of each of the species of plants present on the milacre. These data will form the basis for determining the frequency distribution and dominance of certain plants in various sites, and should assist in correlating reproduction with soil conditions as reflected by plant associations.

Maps were made for each slash plot - the density, height, and kind of slash, whether coniferous, hardwood, or mixed, being indicated. Stumps, residual trees, and skid trails were also mapped. From these maps it was determined that in the process of logging about 10 per cent of the area is devoted to skid trails. Advance reproduction occurring on skid trails is largely destroyed during the swamping and skidding operations. Even though a certain amount of the small reproduction escapes destruction, young hardwoods and weed growth which spring up abundantly on skid trails quickly submerge the small coniferous seedlings.

Plans for next year call for a continuation of experiments with screened slash until results with the rots become evident. Studies of temperature and humidity in the upper and lower parts of pine slash piles will be continued. Some inoculation work is also planned, which it is believed will yield valuable results not only in this project but in any future work involving the rate of decay of wood in this region. Opportunities to do further work in actual comparison of lopped and unlopped slash will be utilized. Observations on progress of rot in slash and the effect of different slash disposal methods on reproduction will be continued on the Cherry

Mountain sample plots. In this connection, Spaulding and Westveld plan to make careful study of a series of permanent sample plots established in Newfoundland in 1920, where various methods of slash disposal and methods of cutting were tried out with many of the same species under consideration in the Northeast. Additional slash plots will be established on the White Mountain National Forest if favorable locations are made available by current timber sales.

Universal Taper and Volume Tables (ME 1, C. E. Behre):

During the past year, due to Mr. Behre's leave of absence, no additional field work was done on the main part of this project. An incidental study, "Theory of tree growth and fundamental principles of tree form", was initiated with the Harvard Forest at Petersham, Mass., with white pine. The object of this study was to study relative growth at two points on the stem and change of form quotient in relation to weather conditions and in response to change of surroundings by thinning or change of crown surface by pruning. Six trees were selected for the study, and the march of diameter growth throughout the season was recorded at breast height and at a point half way between the tip and breast height by means of a steel diameter tape resting on brass supports fixed to the bark and read to the nearest .01 inch by means of a vernier. Three of the trees were codominant individuals in a fairly crowded stand such as might be expected to benefit most by heavy thinning. One of the released trees was immediately prevented from bending in the wind by guy wires in four directions. The second group of three trees was composed of full crowned dominant trees in fairly open position. One of these was left as check, the crown length of the second was reduced one-third by pruning, and two-thirds of the crown was pruned from the third tree.

In all six trees growth started earlier at breast height than at half height, but the growth at the upper point later took the lead and the total growth for the season was much greater at the upper point than at breast height. No stimulation of growth this past season could be observed as a result of thinning. Pruning off two-thirds of the crown resulted in a distinct reduction of rate of growth for the remainder of the season at both points on the stem. Growth takes place during the night for the most part, and diameters usually decrease during the day unless the weather is wet. Fluctuations in growth during the season appear to be directly correlated to precipitation. Growth is stimulated by rainfall, and shrinkage usually occurs in dry periods.

The form quotient of all trees increased during the season. The first season's growth demonstrated no effect of pruning or change of form. The effect of thinning upon form is also indefinite, but increase in form quotient of the thinned trees was greater than for the check tree, with no discernible difference between the free and guyed stems. Neither growth nor change of form could be correlated with wind movement or air temperature in the preliminary study given the weather records.

No additional work under "Technique of volume table construction" and "Change in form after logging" has been done in the past year. Progress under "Factors of average form of standing timber", "Factors affecting butt swell and bark thickness", and "Comparative form of species in mixture" has not been as rapid as hoped. Furlough of Mr. Behre for more than four months last summer halted work for that period, and attention to the Petersham study mentioned above, revision of western yellow pine yield tables, and other minor matters have diverted attention during the past winter. Rapid progress is now being made, and a report should be completed this summer.

Considerable progress was made in the phase of the study dealing with factors of average form of standing timber. Regression coefficients and alienation coefficients have been computed showing the relation between form quotient and various combinations of tree and stand characteristics. Initial computations were made with all available variables included, and on the basis of coefficients thus obtained unimportant variables were eliminated. In this way several trials were made to ascertain the best two or three variable combinations to use in estimating form quotient.

This process of elimination is not entirely satisfactory, and depends in the end to a considerable degree on cut and try. For the most likely combinations alinement charts were made up and corrections for curvature were worked out by Bruce's method.

In these computations the five sets of data were carried forward simultaneously. The results are somewhat discouraging in that the different species do not respond as uniformly to the various factors as was anticipated, and because it does not seem possible to reduce the alienation coefficients much below 60 per cent in any case. In general, it appears that either diameter, height, and site index, or diameter height, and crown per cent give best three variable combinations. For old growth red spruce the alienation coefficients remain so large even when curved that differences in form quotient must be associated with other factors than those which can be given numerical values. Study of variations of average form quotient by types shows a fairly distinct grouping of stands which may be easily applied by observation in the field.

F. Q. 73 applies to old growth red spruce in closed stands quite generally, independent of mixture. It also applies in swamps where trees have characteristic long narrow crowns and have drooping branch habit. (Black spruce type.)

F. Q. 70. Applies to culled or broken stands covering wide range of sites and mixtures.

F. Q. 65 may be used for small sized swamp type spruce, where trees have full crowns of normal habit.

The type groups differentiated for red spruce do not hold for old growth balsam. All the stands except one in swamp type group themselves around average form quotient 67 with a standard deviation of ± 2.2.

In balsam old growth an estimate of average form quotient of the stand based on twenty trees can be obtained from crown per cent and total number of trees per acre over three inches D.B.H., with a standard error of ± 0.87 units.

Progress was also made in the analysis of factors affecting butt swell and bark thickness. The procedure is the same as that used in studying form quotient. From the alienation coefficients it appears that very little of the variation of butt swell can be associated with the measurable factors except in the case of old growth red spruce. It also appears that practically all of the variability which can be accounted for is associated with the diameter of the trees.

In every case, except even-aged balsam, practically all the variability of bark thickness which can be accounted for is also associated with diameter. For even-aged balsam, using age in addition to diameter takes care of practically all the variability associated with the measurable factors.

Because these preliminary results indicate that little will be learned of factors influencing butt swell, primary attention is now being devoted to an equation or chart for estimating the total reduction of D.B.H. for use in applying form class volume tables, rather than to the study of the individual factors of butt swell and bark thickness.

For the total reduction, diameter and age seem to offer best prospects for even-aged stands, but since age is meaningless in the old growth stands, diameter alone, or perhaps some other combination, will have to be used for these stands.

No work has been done on the comparative form of species in mixture.

The work on this project will be pushed to completion as soon as possible. Since it was not possible to do this before Behre was relieved from full time duty, arrangements were made for an assistant to keep at the computations and for Behre to devote part time to the work until the job is finished.

The white pine increment study at Petersham will be continued this year on about the same basis as last year. Current observations with vernier tape will be taken by the fire-weather observer, and these will be supplemented by a dendrograph record on a machine which will be borrowed from the New York State College of Forestry at Syracuse, New York. Behre will keep in touch with the work, and it is hoped that the compilation of results may be undertaken by a graduate student at the Harvard Forest next year.

Growth and Yield of Spruce and Balsam Fir (ME-2: W. H. Meyer, C. E. Behre, and R. C. Wheaton):

Except for the establishment of five permanent sample plots in even-aged stands of spruce of varying degrees of stocking on the Battell Forest in Vermont in cooperation with the state of Vermont, no additional field work was done on this project. A manuscript entitled "Yields of Second Growth Spruce and Balsam Fir in the Northeast" was revised last year by Mr. Meyer in the light of comments made by the Board of Review. The manuscript will appear as a Department Bulletin in the near future.

Plans were drawn up last year by Mr. Behre for carrying on piling tests to determine the solid contents of stacked cords composed of material from second growth stands of different average size. However, Behre was on leave of absence during the entire field season, so no progress was made on this study last year.

At the last meeting of the Research Council considerable time was spent in discussing the need of undertaking this study. The Council agreed that other work, such as the application of spruce normal yield tables to understocked stands and the working up of the data secured from permanent sample plots established some 20 years ago by the Forest Service, should be undertaken first.

Under the present arrangement, R. G. Wheaton will spend a considerable part of the field season in establishing additional sample plots in young stands of second-growth spruce of various degrees of stocking for the study of mortality, approach to normality, change in form, and rate of growth in diameter, height, and volume. As opportunity offers, data will also be gathered for making site predictions through height plots in mature stands of different sites and ages. If time permits, some permanent sample plots in even-aged, mixed hard and softwood stands on old burns will be established. Some time will be spent next winter analyzing the data gathered by Meyer on the application of normal yield tables to abnormal stands.

Relation of Radiation (Light) and Soil Moisture to Tree Growth (T-1, P. R. Gast):

So far, the work carried on in connection with this project has been concerned mostly with technique. Technique is not the object of the project, but it is believed that significant results are ultimately possible only by rigorous scrutiny of technique to insure that the data are sound from the physics standpoint.

The spherical hot-junction thermopiles devised as a part of and for the purpose of this study have so far proven eminently desirable. The next and last step in the development of the light apparatus under this project is now being made. Dr. M. Eppley, owner of the Eppley Laboratory, Newport, R. I., has agreed to attempt the commercial production of these pyrheliometers.

The detailed manuscript report on methods and apparatus for radiometry in silvical research has been completed. The author discusses the physical and chemical aspects and sketches the comparatively meager knowledge of physiology, but does not attempt to deal with silvicultural application. This report will be held in its present form for the use of interested specialists. However, an abstract report has been made which will probably be published as a bulletin from the Harvard Forest by August, 1928.

More evidence has been gathered that the variation in duff moisture which runs concurrently with the variations in relative humidity is due to the effect of relative humidity in screening and diffusing solar radiation. For three months the recording radiometry equipment was running on this aspect of the fire weather study (Pf, B-5). The daily radiation data were obtained for study in connection with the other meteorological records. In addition, screens were set up to shield the duff and thus reproduce the screening effect due to atmospheric moisture. Such records will prove valuable especially if taken in conjunction with the accumulated daily records.

The Livingston method for the dynamic measurement of soil moisture has not been farther developed since the Investigative Program of 1927. Fritted glass seems to be the only desirable material available, but the cost is at present prohibitive. Furthermore, some doubts have been raised as to the validity of the method.

The evidence is cumulative that a significant value for the amount of available water is given by the weight of water in a unit volume of the soil modified by the subtraction of the water below the wilting coefficient. The routine analysis for this water content by gravimetric methods is time-consuming. Mr. Tuttle of the Forest Products Laboratory developed a method for the "capacity" measurement of water in wood. An attempt to apply this same method to the measurement of water in soil and in pine needle duff has been made. A change in the moisture content of the soil is accompanied by a change in the electrical capacity of the sample. Because of the presence of the necessary ground in the measuring circuit, an artificial condition is necessary in that the soil to be measured must be electrically insulated from the rest of the ground. Further development work on this part of the project is in order.

The adaptation of this method to the measurement of moisture in the duff is made difficult by the small weight of water introduced. The duff is not as dense as an equal volume of wood; the specific gravity is very low; so that even a 50 per cent water content means but a small weight of water as a factor inducing a variation in the electrical capacity of the condenser. A condenser into which a large volume of loose duff may be compressed is being put together for further experimental work.

The work planned for the coming summer will be continued along the following two major lines: (1) The observations on radiation on the methods-of-cutting area in mixed hemlock - white pine in the Adams Fay Lot at Petersham, Mass.; (2) the moisture determinations will be made on the soil of these plots, and the assay of the value of the electrical method will be continued as a part of this project.

This project is planned to deal with field material. Both radiation and soil moisture affect the plant not only directly but also indirectly, through making more available nutrients from organic material in duff, humus, and soil. Of these, nitrogen is of preeminent importance. It seems obvious that nitrogen availability determinations must be run currently with observations on radiation and soil moisture. Should a properly qualified student elect for his work at the Harvard Forest a study of nitrogen, it will be possible to advance the project by following the course of nitrogen availability in the soils in the different plots. It will be highly desirable to work with seedlings of the same parentage in these tests. As a part of the project it would be advantageous to fertilize the cones of a vigorous pine with the pollen of another vigorous pine, and thus produce a uniform stock to be held for these tests. One of the projects to be carried on at the Gale River sub-station will be the provision for spruce for these tests.

Weather and Fuel Relationships (Pf. B-5, P. W. Stickel):

Because of the continued cooperation in this project (see section heading Cooperation), it was possible not only to maintain all of the stations in operation last year, but to open a fourth station at Smyrna Mills, Maine, in the spruce-balsam fir type in cooperation with the Maine Forest Service. At this last station, as well as at the Petersham station, inflammability tests were made using pipe heels, cigarettes, and matches in the duff of various moisture content. The time of observations and factors measured were similar to the previous year. Daily telegraphic communications of the Cranberry Lake station and Smyrna Mills station observations were sent to the Albany, N. Y., and Boston, Mass., Weather Bureau offices. The officials in charge of both of these offices spoke very highly of the value of the data in aiding the forecasting of forest fire weather.

The Petersham station served as a central experimental area for the fire-weather work. In addition to the empirical inflammability work, an experiment was undertaken to find out the effect of different light intensities upon duff moisture content. (See T-1.) Three different light intensity stations were established using duff hygrometers for measuring duff moisture content, mercurial thermometers for measuring the duff temperature, and thermopiles for measuring the radiation. The duff hygrometers of the stations in the clear-cut area served for the full exposure area. Frames covered with various thicknesses of cheesecloth were used to produce the other two different light intensity areas. One screen permitted approximately 50-60 per cent of full radiation to fall upon the duff, while under the other screen there was only about 30 per cent of full radiation. As was to be expected, both duff temperature and duff moisture content varied under the three light conditions. Unfortunately, this work was started so late in the year that the low position of the sun on the horizon and its interference by neighboring trees caused results that were not uniform. In general, the duff temperature increased while the duff moisture content decreased, with increase in radiation intensity. The duff moisture content in the fully exposed area normally begins to fall as soon as the morning sun raises the duff temperature. Under the screen giving from 50-60 per cent of radiation, the duff did not begin to dry out until around 11 a.m., while under the still more shaded area the duff moisture content began to fall only in the late afternoon. It is hoped that this special phase of the fire-weather work will be continued next year.

The problem of securing more accurate evaporation readings has been troublesome. Dr. Gast suggested that perhaps the volume replacement method could be improved by using a weight replacement method. While this last method is the more accurate of the two, the added burden of additional equipment necessary for weighing the atmometers has not recommended its use to the fire-weather work. During the field work, the amount of water replaced in the one set of instruments was weighed as well as its volume noted. With approximately 300 readings of weight vs. volume replacement, the inaccuracy of the volume replacement method can be determined and the nexcessary correction factor applied in the future.

Some five hundred inflammability tests have been completed, four hundred in the white pine duff at Petersham and one hundred in the mixed spruce fir duff at Smyrna Mills. The fire brands used were matches, pipe heels, and cigarattes, listed in order of their danger in starting fires. In both types of duff the zone of greatest hazard appears to be when the duff moisture content falls below 20 per cent. This conclusion is further substantiated by a comparison of duff moisture content data and the records of forest fires. No tests with the electric hot wire apparatus were made during the past field season.

The coding and transferring of the 1926 field data to punch cards was completed during the early part of 1927. These data were for the following fire-weather stations; Cranberry Lake, N. Y., Elk Lake, N. Y., and Petersham, Mass. The Cranberry Lake station located in the northern mixed hardwood-softwood type has been in operation two years, while the Elk Lake station situated in the lower pure spruce slope type and the Petersham station located in the white pine type have been in operation for one field season. At all three stations readings of the most important meterological factors and duff moisture content were taken four times daily - 8 a.m., 11 a.m., 2 p.m., and 5 p.m. - in timbered areas and closely adjacent clear-cut areas. The Petersham fire weather records included also a short series of the light records from the project dealing with light in relation to tree growth (T-1). While no intensive statistical analysis of the tabulated data was made, a preliminary examination of the records shows that there is a distinct correlation between forest fire hazard and weather. The correlation is especially striking between duff moisture content and relative humidity, duff temperature, and light intensity.
Since the number of inflammability tests made in white pine duff at Petersham were insufficient to give conclusive proof of the relative hazard under various moisture contents, no report was prepared on this phase of the work.

It will be possible to continue operating the four stations during the coming field season of 1928. In its present status the regional fire-weather stations are located in very representative and important forest types. To round out the field work, at least two more stations should be placed in operation as soon as funds are available. One station should be established in the pitch pine region of Cape Cod and a second one in the southern mixed hardwood type such as is found in southern Massachusetts, southern New York, and Connecticut.

In addition to the regular routine work of the stations, it is planned to finish the empirical inflammability work at Petersham and Smyrna Mills. The Petersham tests will be completed when a series of camp fire tests have been made. It is also hoped that inflammability work will be initiated at Cranberry Lake and Elk Lake. At Petersham the light work will be continued and inflammability tests made with the hot wire apparatus.

Sufficient data have now been secured at some of the stations so that a really intensive statistical analysis of the data can be made. This, as well as transferring the 1927 field data to tabulation sheets, will be done as soon as possible. The analysis will serve for a practical application of these data to forecasting fire weather next year.

Prediction of Fire Hazard (Pf. C-7, F. C. Crombie):

This project, which is primarily a Weather Bureau project, is being carried on in cooperation with the Northeastern Forest Experiment Station and other organizations interested in the study of the relation between weather conditions and fire hazard. Since 1926 Mr. Crombie has devoted his entire time to the study of fire-weather forecasting in the Northeast. Through personal contacts which he established with state foresters and the White Mountain National Forest he was able to get seventeen special fire-weather stations installed. In addition to these stations, the Massachusetts Agricultural Experiment Station and the Winter Hill Observatory at Worcester, Mass. extended their cooperation by furnishing the desired records and sending telegraphic reports as needed.

Telegraphic reports can be received from all these stations daily as the needs of the service require them. However, owing to the late installation of much of the equipment, not all were requested to transmit them last season.

Forecasts were issued daily from the Boston office by Mr. G. A. Loveland, Official in Charge, during hazardous periods last season and will be issued again this coming season as the needs of the service require them. These forecasts are distributed to the various sections of New England by telegraph and are indicative of the conditions which will occur in the section to which they are sent. Much improvement is anticipated relative to the forecasts for the coming season; and as the Weather Bureau, in close cooperation with the Northeastern Forest Experiment Station, determines more accurately just what is needed in a forecast, every effort will be made to keep abreast of the needs.

As a means of improving the forecasting service, much work has been done in preparing weekly normal, weekly mean maximum, weekly mean minimum, and weekly absolute maximum temperatures from March to December for each of the ten sections into which the New England states have been divided for fire weather purposes. This phase of the work was completed in January, and other essential features of fire weather are being taken up for study and correlation as rapidly as time permits.

Analysis of Forest Fire Statistics (Pf. D-2: S. T. Dana and P. W. Stickel):

Owing to Mr. Dana's resignation as director of the Station, he was not able to devote the time necessary to complete the analysis of the fire data. Fire records have been tabulated and compiled for the four states with which the Station is cooperating, as follows:

Maine	1915-1926
New Hampshire	1921-1925
Vermont	1909-1926
Connecticut	1921-1925

This has entailed a great deal of detailed work and has, therefore, been a long and laborious job. The figures for each state are now in such shape as to make possible the preparation of an analytical report, which it is hoped will be published in each case by the state concerned. Unfortunately, the analysis has not gone far enough to make it practical to include even tentative conclusions in the present investigative program. Perhaps the outstanding facts are the incompleteness and inaccuracy of a very large portion of the reports. This condition emphasizes the desirability of general adoption of the uniform individual fire report agreed upon at the Boston conference of state foresters two years ago, and also the need of insisting upon better reports from the fire wardens if they are to prove of much real value.

It is clear that a thoroughgoing analysis of really first-class reports can help greatly to a better understanding of the forest fire situation and, therefore, to the better organization of fire control activities; but that analysis of incomplete and inaccurate data may be actually misleading. Final reports for the various states are in preparation and will probably be finished approximately in the following order: Maine, New Hampshire, Vermont, and Connecticut.

Habits and Control of the White Pine Weevil (Pi-4, H. J. MacAloney):

The field work in 1927 was restricted to (1) checking information already obtained on hibernation and flight habits, and the removal of infested leaders; and (2) inspection of the permanent sample plots. From June 1 to August 24 Mr. MacAloney was in New Brunswick and Nova Scotia coordinating the work done by the Dominion Entomological Branch with that in the Northeastern states. Additional work was reported from Vermont by Mr. Marble, and his data have been turned over to the Station for use in the preparation of the report.

Hibernation takes place in the litter beneath the trees, and experiments continued from 1925 show that there is probably a great mortality during this period. In all the experiments conducted, in cages and stands, only two weevils emerged in the spring.

Further experiments with banding materials show that weevils will fly directly to the leaders when there is a temperature high enough to enable them to fly readily. Early in the spring, before the temperature is 70°F. or higher, they crawl up the trees, reaching the leading shoots by that method. Raw wool was used in 1927 for banding experiments. This proved as effective as the tanglefoot used in 1926 and is somewhat less expensive. Examination of the plots tanglefooted in 1926 showed that the infestation was as high as in the surrounding areas, which seems to indicate that tanglefoot is effective for one season only. Additional work will be done with the raw wool in 1928.

Results of further work in removal of infested leaders revealed the fact that this is not a satisfactory means of control in localities where there is an impending source of reinfestation. In stands which are isolated and which have a small amount of infestation, this method should be practicable. This is also true with respect to forests which are being preserved for their aesthetic value. In areas where the annual infestation is severe, the cost may exceed one dollar per acre per year, which is prohibitive.

With the exception of observations made in New Brunswick and Nova Scotia, no work was done on control by biological agencies. In several areas in these provinces leaders were found to be heavily parasitised, many of the leaders showing nearly 100 per cent parasitism. However, in other areas there was very little parasitism evident. This bears out the contention advanced by many entomologists that control by parasites is uncertain. A considerable number of leaders in these stands were also stripped by birds, but none of the birds was observed in the act of feeding on the weevil larvae.

The information procured by studying nearly three hundred permanent and semipermanent sample plots laid out during the last four years in Massachusetts, Connecticut, Vermont, New Hampshire, New York, and the Canadian provinces of New Brunswick and Nova Scotia is in accord with that obtained in previous studies in indicating clearly that under certain forest conditions the injury may be substantially decreased. The greater part of weevil damage occurs in stands which are below par in site and reasonable minimum stocking.

Given optimum site conditions, increased density of stocking will tend to keep the weevil injury at a minimum. Such a stand, however, is feasible only when it can be produced naturally and at a high enough density to offset any weeviling which may occur. Sparsely spaced stands, such as those found on the medium soil of abandoned farm lands common to New England, are generally heavily infested. In pure stands both natural and artificial, and with growing conditions similar, the greater the number of trees per acre the less will be the percentage of weeviling. An additional disadvantage with which the forest owner will have to contend if a pure stand is to be produced is the lack of natural pruning.

As stated in the Report for 1927, the cheapest and most advantageous way to protect white pine from the weevil and to control the injury is to grow it in mixture, preferably with species that will be of value in the final crop. The choice of the other species in the stand will be determined largely by the economic conditions in any given locality. The better hardwoods, such as oak, ash, and hard maple might be used in New England where in the future there should be a market for good lumber of these species. In Maine and the Maritime Provinces there is more likelihood of a market for pulpwood, from both broadleaved and coniferous species, and consequently such mixtures should be used. Except where fuelwood is desired, it is doubtful if it would be advisable to use the poorer hardwoods, such as gray birch and fire cherry.

The groupwise system of growing stands seems to be better as a means of control than a stemwise stand, as there is not so much danger from whipping and overtopping. By judicious weeding so that the pines will not be crowded out, pine groups can be kept fairly well segregated, and the final stand will contain groups of pine of much better quality than can be grown in pure stands. Weeding will be necessary in the early years to prevent crowding and abrasion, and thinnings will have to be made systematically as the stand becomes older. Aside from the protection offered, another advantage in growing pine in mixture is that it cleans itself of its lower branches relatively early in life. Pines will be fewer in number in a mature mixed stand than in a pure pine stand, but those surviving will be clean boled and straight, and produce lumber of higher quality.

Publication of the manuscript is expected in the early part of 1929. The early part of the field season of 1928 will be utilized in checking existing information on hibernation, flight, feeding, and oviposition habits. Some valuable additional information is expected from cages constructed in the spring of 1927. The examination of the permanent plots will be carried on as heretofore.

Control of the Bronze Birch Borer (Pi-6: R. C. Hall and H. J. MacAloney):

The bronze birch borer has proved to be a very important factor in the management of stands containing an appreciable representation of birch. This project was added to the Station program in 1925 as a minor project with the intention of giving it major significance as soon as sufficient appropriations were made available for carrying the work out on an adequate basis. This insect is quite generally distributed throughout the range of the birches in the Northeast, attacking all species but being particularly injurious to the yellow and white birch in second-growth stands.

In these second-growth stands it becomes a serious pest after logging operations, fire damage, or where part of the stand has been thinned by defoliators.

The work so far has been confined to life history studies of the insect and to a study of conditions in permanent sample plots laid out in the White Mountain National Forest and the Corbin Park Game Preserve in New Hampshire. Observations on recently cut over areas show excessive damage from this insect. It is evident that a different method of cutting must be employed if any return is to be expected from the birch which is left after logging.

Plans for the next field season contemplate an extensive survey of the problem through the establishment of semi-permanent sample plots in as many localities as may be possible. Cooperation in this work is expected from the Michigan School of Forestry and Conservation and the Lake States station of the Division of Forest Insects. The investigation of the permanent plots and the life history studies instituted last year will be continued.

Minor Projects

In view of the full discussion which appeared in the Investigative Program for 1927 in regard to the purpose and status of the various minor projects, and the fact that all of the essential information for each project appears in the status sheets, only these projects on which unusual developments have occurred during the past year or in which important progress has been made will be discussed here.

European Larch Canker(Pd 4, Perley Spaulding):

The discovery of the European larch canker in eastern Massachusetts by members of the Harvard Forest in the spring of 1927 has compelled the giving of considerable time to the study of this serious disease. The disease has been found largely in plantations of European larch. The species of trees so far found attacked are *Larix europea*, *L. laricina*, *L. leptoleptis*, *Pseudotsuga taxifolia*, and possibly *Pinus sylvestris* and *P. rigida*. Infection of European larch reaches 100 per cent in the worst places, while infection of Douglas fir is as high as 80 per cent. The most serious aspect of this discovery is the heavy attack on neighboring Douglas firs. This disease becomes a sinister threat to one of the most important timber trees on the continent. Future work on this project depends entirely upon the allotment of funds for the work.

Replacement of Chestnut (M 3, P. W. Stickell):

Another plot, forming the third of this series, was established on the Mount Toby Forest in October, 1927, on an area from which the dead chestnut had not been removed and no white pine planted; in contrast to the first two plots, where the dead chestnut had been cut and pine planted in order to determine the feasibility of converting the stand to white pine. The third plot will serve to show the natural development of stands which have been hit by the chestnut blight.

Management of Sprout Hardwoods (M 2, M. Westveld):

An inspection of the five plots which form the basis of this experiment revealed the fact that wood-choppers had disregarded the instructions of the local fire warden and cut into the isolation strip of one of the plots. These plots will be remeasured next year, at which time one of the burned-over plots will be reburned.

Pruning of White Pine (Mp-1, F. W. Stickel):

Although the plans for 1927 called for the establishment of the first of a series of three plots on Mt. Toby for the purpose of determining the effect of pruning on white pine at various ages and stands of different densities, the work was not started. It is hoped that time will be found this year to get the project under way.

Research on White Pine Blister Rust (Pd-2, Perley Spaulding):

Studies in Europe indicate that the Balkan white pine, Pinus peuce, is very resistant if not immune to the white pine blister rust. Seeds of this species and other European white pine resistant to the disease are being distributed to foresters in the Northeast and Pennsylvania to determine their suitability for planting in this region.

Permanent Sample Plots (M-5, M. Westveld):

Remeasurement work on the remaining permanent sample plots established by the Forest Service in 1905 and 1906 was continued during 1927. A group of seven of these plots at Sherburne, Vermont, was remeasured in cooperation with the Vermont Forest Service. Vermont also gave assistance in the establishment of five spruce yield plots, two methods-of-cutting plots, four cleaning plots, and three slash disposal plots. Additional spruce yield plots will be established during this coming field season.

Routine measurements and observations were also maintained during the past year on the following minor projects:

Source of Seed - Scotch Pine (Fs-d-1) - M. Westveld.

Management of Eastern Hemlock (M-4) - R. G. Wheaton.

Chestnut Blight (Pd-1) - Perley Spaulding.

Pitch Pine Blister Rust (Pd-3) - Perley Spaulding.

Practice of Forestry by Private Owners (M-1, WO) - Staff.

Regional Yields (ME-1, WO) - Staff.

Converting Factors (ME-2, WO) - Staff.

Manual of Field Methods (ME-4, WO) - Staff.

New Projects

The Station proposes to add to its schedule this year "Phenological observations of the important trees in the Northeast" to be handled as a staff project Flowering, fruiting, and leafing habits of trees can be definitely tied in to silvicultural and protective measures. Fire weather conditions, emergence of insects, fruiting of fungi, etc., may be collated with certain stages in phenological processes. Considering the national character of the phenological study and the initiation of such a study by the forest experiment stations throughout the country, it seems desirable to draw up a plan and forms for the study on a wide scale, so designed as to be usable throughout the United States. In order to handle adequately a project of this sort, it will be necessary to depend to a great extent on the assistance of outside agencies, botany departments in the various schools, state foresters, agricultural experiment stations, natural history museums, etc., in securing the desired information. In order to secure anything like real averages for the region, records must be obtained over a period of several years. The basic data will be compiled into charts and maps, and the results published. All members of the staff will participate in this project, but the responsibility will rest with a designated person.

Publications

Last Year's Publications

The following papers were published during the past year:

"Form Class Taper Curves and Volume Tables and Their Application" by C. E. Behre. Published in the Journal of Agricultural Research, Vol. 35, No. 8. Oct. 15, 1927.

"Insolation and Silviculture with Reference to Studies at the Harvard Forest" by P. R. Gast. Typewritten report.

"Studies in the Humus Layers of Coniferous Forests, Their Peculiarities and Dependence on Silviculture" by Honrik Hesselman. Translated by P. R. Gast and P. W. Stickel. Mimeographed by Department.

"The White Pine Blister Rust in Europe" by Perley Spaulding. Published in Report of the Proceedings of the Twelfth Annual Blister Rust Conference, 1927.

"The European Larch Canker in America" by Perley Spaulding and P. V. Siggers. Published in Science, November 18, 1927.

"Foresters Urged to Test Balkan White Pine" by Perley Spaulding. Published in the Forest Worker, November, 1927.

"Spaulding Comments on Susceptibility of Sugar Pine" by Perley Spaulding. Published in Blister Rust News, March, 1927.

"The Natural Replacement of Blight-Killed Chestnut in the Hardwood Forests of the Northeast" by C. F. Korstian and P. W. Stickel. Published in the Journal of Agricultural Research, Vol. 34, No. 7, 1927.

"The Natural Replacement of Blight-Killed Chestnut" by C. F. Korstian and P. W. Stickel. Published by U. S. Department of Agriculture, Miscellaneous Circular No. 100, April, 1927.

"Forest Fire Weather Research" by Paul W. Stickel. Published in Journal of Forestry, May, 1927.

This Year's Publications

"Preliminary Yield Tables for Western Yellow Pine" by C. E. Behre. (Popular Edition.) Estimated length 12 printed pages plus 3 tables and 6 figures. Suggested for publication as Bulletin of the University of Idaho. Already accepted for publicatior

Preliminary Yield Tables for Western Yellow Pine" by C. E. Behre. (Technical Report.) Estimated length 24 printed pages plus 9 tables and 12 figures. Accepted for publication by the Journal of Agricultural Research.

"Studies on the Application of Form Class Volume Tables to Red Spruce, White Spruce, and Balsam Fir" by C. E. Behre. Estimated length 40 printed pages plus 10 tables and 6 figures. Suggested for publication in the Journal of Agricultural Research. Ready for submission summer 1928.

"Timber Growing and Logging Practice in the Northeast" by S. T. Dana. Estimated length 40 printed pages. Suggested for publication as a Department Bulletin. Ready for submission 1928.

"Forest Fires in Maine 1915-1926" by S. T. Dana. Estimated length 15 printed pages plus 6 tables and 6 figures. Suggested for publication as a bulletin of the Maine Forest Service. Ready for submission 1928.

"Forest Fires in New Hampshire 1921-1925" by S. T. Dana. Estimated length 12 printed pages plus 6 tables and 6 figures. Suggested for publication as a bulletin of the New Hampshire Forestry Commission. Ready for publication 1928.

"Forest Fires in Vermont 1909-1926" by S. T. Dana. Estimated length 12 printed pages plus 6 tables and 6 figures. Suggested for publication as a bulletin of the Vermont Forest Service. Ready for submission 1928.

"Forest Fires in Connecticut 1921-1925" by S. T. Dana. Estimated length 12 printed pages plus 6 tables and 6 figures. Suggested for publication as a bulletin of the Connecticut State Park and Forest Commission. Ready for submission 1928.

"A Thermo-electric Radiometer for Silvical Studies" by P. R. Gast. Estimated length 50 printed pages plus 16 figures. Suggested for publication as Harvard Forest Bulletin. Ready for submission August, 1928.

"Yields of Second Growth Spruce and Fir in the Northeast" by W. H. Moyer. Estimated length 20 printed pages plus 45 tables and 20 figures. Submitted for publication as a Department Bulletin.

"Decay of White Pine Slash" by Perley Spaulding. Submitted for publication as a Department Bulletin.

"A Preliminary Investigation of the Disposal of White Pine Slash" by Perley Spaulding and L. S. Altpeter. Summary of Spaulding's Department Bulletin to be included in a proposed Harvard Forest Bulletin. Already submitted for publication.

"The White Pine Blister Rust: a Comparison of American and European Conditions" by Perley Spaulding. Submitted for publication as Department Bulletin.

"Forest Fire Weather Research" by P. W. Stickel. Published in mimeographed form January, 1928, by Quebec Forest Industries Association.

"Podsel Soil: Its Physical Characteristics and Silvicultural Importance" by P. W. Stickel. Published in Ecology, April, 1928.

"Comparative Forest Fire Hazard in the Northeast" by P. W. Stickel. Published in the Journal of Forestry, April, 1928.

"Forest Fires in Central Massachusetts, 1927" by P. W. Stickel. Estimated length 5 printed pages plus 2 tables and 1 figure. Accepted for publication by Monthly Weather Review.

"Studies of the Development of Coniferous Plants in Raw-humus. I. The Significance of the Nitrogen Mobilization in the Rawhumus Layer for the Early Development of Pine and Spruce Plants" by Renrik Hesselman; and "Studies of the Development of Coniferous Plants in Rawhumus. II. The Development of Mycorrhiza on Pine Seedlings in Various Forms of Rawhumus" by Elias Nolin. Translated by P. W. Stickel. Translation of other papers on mycorrhiza to be included to bring the work up to date. Estimated length 100 double spaced typewritten pages. To be submitted for mimeographing. Ready in summer of 1928.

"Relation between Relative Humidity and Radiation in Their Effect upon Duff Moisture Content" by P. R. Gast and P. W. Stickel. Estimated length 1 printed page and 2 figures. Suggested for publication in the Monthly Weather Review. Ready for submission fall of 1928.

"Comparison of Volumetric and Gravimetric Methods of Determining Evaporation with Atmometers" by P. W. Stickel and A. W. Gottlieb. Estimated length 4 printed pages plus 2 tables and 2 figures. Suggested for publication in Ecology. Ready for submission summer of 1928.

"Effect of Wind Velocity upon the Rate of Evaporation from Atmometers and Evaporimeters" by P. W. Stickel and A. W. Gottlieb. Estimated length 4 printed pages plus 2 tables and 3 figures. Suggested for publication in Ecology. Ready for submission in summer of 1928.

"Reproduction on Cut-over Pulpwood Lands in the Northeast and Suggestions for Their Management" by M. Westveld. Estimated length 35 printed pages plus 27 tables and 24 figures. Submitted for publication as a Department Bulletin.

"Observations on Cut-over Pulpwood Lands in the Northeast" by M. Westveld. Estimated length 10 printed pages plus 2 tables and 2 figures. Accepted by the Journal of Forestry for publication.

"Growth on Cut-over Pulpwood Lands in the Northeast" by M. Westveld. Estimated length 20 printed pages plus 10 tables and 10 figures. Suggested for publication in the Journal of Agricultural Research. Ready for submission fall of 1928.

"Influence of Seedbed Conditions on Reproduction of Spruce and Balsam Fir" by M. Westveld. Estimated length 5 printed pages. Suggested for publication in Journal of Forestry. Ready for submission fall of 1928.

"Reproduction Conditions on Cut-over Pulpwood Lands in the Northeast" by M. Westveld. Submitted for publication in 1927 Yearbook.

"Habits and Control of the White Pine Weevil" by H. J. MacAloney. Estimated length 35 printed pages, 5 graphs, and 10 plates. Suggested for publication as a technical bulletin by the New York State College of Forestry. Ready for submission December, 1928.

"Habits and Control of the White Pine Weevil" by H. J. MacAloney. Estimated length 20 printed pages. Suggested for publication as a Farmers' Bulletin. Ready for submission summer of 1928.

Finances

Appropriations for Silvical Investigations

Estimated expenses of the Station for the fiscal year 1929 on the basis of an allotment of $27,000 are as follows:

Salaries, permanent personnel	$ 20,032
Salaries, temporary personnel	2,660
Expenses	3,150
Automobile operation and maintenance	500
Telephone and telegraph	125
Freight and express	50
Equipment and supplies	483
	$ 27,000

The above statement is based on the assumption that there will be no increase in our budget over last year. No attempt has been made to fill the vacancy caused by the transfer of Mr. Meyer. The month thus made available has been used to excellent advantage for the employment of junior scientific aids to assist in the compilation of the field data. Although Mr. Wheaton has been added to the Station staff during the past year, no permanent increase in the Station force will result, since Mr. Behre resigned as Associate Silviculturist in April. The latter is, however, included in next year's budget as an agent, in order to provide for the completion of certain work which will carry into the next fiscal year.

The increased estimate for automobile operation and maintenance over last year is due to the fact that an additional car is being purchased this year, making two government cars operated and maintained by the Station.

It is needless to call attention to the fact that $27,000 a year is wholly inadequate to provide for the needs of the Northeast. The work to date has been largely concentrated in the spruce types of the north. The work should be expanded and studies initiated in neighboring regions.

Cooperative Funds

A balance of $1,305.89 still remains of the cooperative fund for forest insect investigations in Maine. This money is being held for the payment of certain of Peirson's expenses and for such assistance as he may employ in connection with his work. Kenneth Salman, who was employed last year by Mr. Peirson, will spend three months again this year in Maine with Peirson on entomological studies. Mr. Salman's salary of $150 a month will be paid from the cooperative fund, the Maine Forest Service having agreed to pay his expenses.

Continuation of the fire weather study has been made possible through the interest and financial aid given by cooperators. The Harvard Forest is again contributing $1,000 for the maintenance of the fire weather station at Petersham, the Maine Forest Service is financing the station at Smyrna Mills, Maine, the New York State College of Forestry will take over the maintenance of the Cranberry Lake, N. Y. station the first of June and continue for the remainder of the season, while the Elk Lake, N. Y. station will be maintained this year by the New York Conservation Department and Finch, Pruyn and Company. The funds contributed for the fire statistics studies have been exhausted. The fund furnished for the white pine weevil study being handled by the Bureau of Entomology will be exhausted by August 31.

Appointments expire in 1930:

W. G. Howard	Conservation Department.
Prof. R. S. Hosmer	Cornell University.

Appointments expire in 1929:

Dean Franklin Moon	New York State College of Forestry.

Appointments expire in 1928:

R. S. Kellogg	News Print Service Bureau.

Station Personnel

Northeastern Forest Experiment Station
Amherst, Mass.

(Established 1923)

J. S. Boyce	Director
M. Westveld	Associate Silviculturist
P. W. Stickel	Assistant Silviculturist
R. G. Wheaton	Assistant Silviculturist
Perley Spaulding	Forest Pathologist
H. J. MacAloney	Forest Entomologist
P. R. Gast	Agent
W. B. Barrows	Computing Clerk
Mary E. Turrell	Senior Clerk
Rose M. Delaney	Assistant Clerk
Kathryn E. O'Neil	Assistant Clerk